4. COST ESTIMATES

Two types of cost estimates have been generated for each of the three alternatives, a total project cost (TPC) and a life-cycle cost. The TPC is defined in DOE Order 413.3, *Program and Project Management for the Acquisition of Capital Assets,* as the total estimated cost (TEC) of a construction project plus the preconstruction costs such as conceptual design and research and development, and the costs associated with the preoperational phase such as training and startup costs. The TEC of a construction project is the gross cost of the project, which include the cost of land and land rights; engineering, design, and inspection; direct and indirect construction; and initial equipment necessary to place the plant or installation in operation, whether funded as operating expense or construction. Given the phase of the project (feasibility), some of the cost accounts such as Project Management, Engineering, and Project Controls are developed using percentages of the construction cost. These percentages are based on historical experience at the INEEL. After the initial cost estimates were developed, contingency analyses were performed for each of the alternatives. These contingency analyses rated the degree of the scope definition, project complexity, and amount of innovation required for the project. These ratings were then used to develop contingency percentages based on historical performances of other DOE projects. TPC cost information is provided in Section 4.1.

The life-cycle cost estimates include the TPC as well as the costs of operations, maintenance, consumable materials, and decontamination, decommissioning, and dismantling (DD&D) of the facility. Operations labor estimates were developed from estimates of the staffing requirements. Maintenance costs were estimated as a percentage of the overall facility capital cost. Yearly usage of consumables such as fuel and HEPA filters were estimated from the process flow diagrams or, in the case of the HEPA filters, operating history at existing facilities. Total power demand was estimated from the equipment lists and one-line diagrams and an average use factor was applied to determine the yearly power use. DD&D costs were determined based on the facility capital costs and factors developed by the INEEL DD&D Program. Life-cycle cost information is provided in Section 4.2.

Both the TPC and the life-cycle cost include escalation, the increase in cost for the same amount of work over time, and contingency. A discounted life-cycle cost has also been computed, in which the hture costs of the facility are 'brought back" to the present using the discounting rates provided in the Office of Management and Budget Circular A-94, "Guidelines And Discount Rates for Benefit-Cost Analysis of Federal Programs."

4.1 Total Project Costs

Bechtel Estimating Services prepared a risk adjusted project support cost estimate for each of three retrieval alternatives. Included in the estimates are costs for environmental safety, health, quality, engineering, procurement, construction, startup and turnover, project management, escalation, and contingency. Summaries of the estimates in the major elements of the work breakdown structure are presented in Tables 3–5.

The total project costs for each alternative are as follows:

Alternative 1 – $292M

Alternative 2 – $268M

Alternative 3 – $271M.

The estimated total project costs of Alternative 2 are approximately $3 million lower than Alternative 3 and $24 million lower than Alternative 1. For more detailed information see the retrieval Cost Estimate Support Data Recapitulation form under a July 3,2003, Interoffice Memorandum to S. L. Austad from R. D. Adams/S. N. Wasley containing three adjusted project support estimates for the Pit 9 Remediation Project. An electronic copy of the full details of these estimates can be found on the accompanying CD.

Table 3. Alternative 1 capital costs ($K).

Description	Estimate Subtotal	Escalation	Contingency	Total
Environmental, Safety, Health, and Quality	$13,740	$1,114	$6,403 (43.1%)	$21,257
Design Engineering	$21,213	$1,312	$15,048 (66.8%)	$37,573
Procurement	$44,631	$3,620	$26,905 (55.8%)	$75,156
Construction	$76,652	$10,241	$41,058 (47.3%)	$127,951
Testing and Turnover	$7,318	$1,177	$6,099 (71.8%)	$14,595
Project Management	$9,546	$1,021	$4,555 (43.1%)	$15,122
Total Project Cost	$173,100	$18,446	$100,069 (52.2%)	$291,654

Table 4. Alternative 2 capital costs ($K).

Description	Estimate Subtotal	Escalation	Contingency	Total
Environmental, Safety, Health, and Quality	$12,551	$1,018	$5,809 (42.8%)	$19,378
Design Engineering	$19,364	$1,198	$13,641 (66.3%)	$34,203
Procurement	$40,930	$3,319	$24,506 (55.4%)	$68,755
Construction	$70,507	$9,420	$39,184 (49.0%)	$119,110
Testing and Turnover	$6,661	$1,071	$5,514 (71.3%)	$13,246
Project Management	$8,714	$932	$4,130 (42.8%)	$13,776
Total Project Cost	$158,726	$16,958	$92,783 (52.8%)	$268,467

Table 5. Alternative 3 capital costs ($K).

Description	Estimate Subtotal	Escalation	Contingency	Total
Environmental, Safety, Health, and Quality	$12,551	$1,018	$5,863 (43.2%)	$19,432
Design Engineering	$19,364	$1,198	$13,769 (67.0%)	$34,330
Procurement	$42,172	$3,420	$25,484 (55.9%)	$71,076
Construction	$70,507	$9,420	$39,551 (49.5%)	$119,477
Testing and Turnover	$6,661	$1,071	$5,565 (72.0%)	$13,298
Project Management	$8,714	$932	$4,168 (43.2%)	$13,814
Total Project Cost	$159,967	$17,059	$94,400 (53.3%)	$271,426

4.2 Life-Cycle Cost

The life-cycle cost estimates include the TPC, operating costs (including labor and materials), and post-operational (DD&D) costs. These costs are escalated using the project schedule and the INEEL cost estimating guide. Total life-cycle cost estimates with management reserve and contingency for each alternative are as follows:

Alternative 1 – $520M

Alternative 2 – $472M

Alternative 3 – $473M.

The life cycle cost estimate for Alternative 2 was $1 million lower than Alternative 3 and $48 million lower than Alternative 1. For more detailed life-cycle cost information see Appendix D Tables 6, 7, and 8 summarize the estimated life-cycle costs for each alternative.

Table 6. Alternative 1 life-cycle cost ($K).

Description	Estimate Subtotal	Escalation	Contingency	Total
Total Project Cost	$173,124	$18,487	$100,087	$291,698
Operations	$158,302	—	$34,299	$192,601
Post Operations	$19,358	$6,278	$9,656	$35,293
Total Cost	$350.765	$24.765	$144.042	$519.593

Table 7. Alternative 2 life-cycle cost ($K).

Description	Estimate Subtotal	Escalation	Contingency	Total
Total Project Cost	$158,775	$16,963	$92,819	$268,557
Operations	$149,600	—	$21,941	$171,541
Post Operations	$17,751	$5,757	$8,855	$32,362
Total Cost	$326,125	$22,720	$123,615	$472,460

Table 8. Alternative 3 life-cycle cost ($K).

Description	Estimate Subtotal	Escalation	Contingency	Total
Total Project Cost	$159,988	$16,892	$94,415	$271,294
Operations	$151,316	—	$22,193	$173,509
Post Operations	$17,890	$5,802	$4,541	$28,233
Total Cost	$329193	$22,694	$121,149	$473,036

5. SCHEDULE ESTIMATES

Several enforceable deadlines have been established for the OU 7-10 interim remedial action in the *Agreement to Resolve Disputes* (DOE-ID 2002) between DOE, the Environmental Protection Agency, and the State of Idaho. The *Agreement to Resolve Disputes* requires that DOE:

- Submit the 10% design by September 2005
- Complete the remedial design for Pit 9 Remediation Project and commence construction no later than March 31, 2007
- Commence Pit 9 Remediation Project operations no later than 36 months after the start of construction.

A preliminary schedule (see Figure 33) for the three retrieval alternatives shows how the Pit 9 Remediation Project will meet these enforceable deadlines. Since the schedule is similar for each alternative, only the schedule specific to Alternative 2 was provided. The representative schedule was developed based on the process of review and approval at critical decision points.

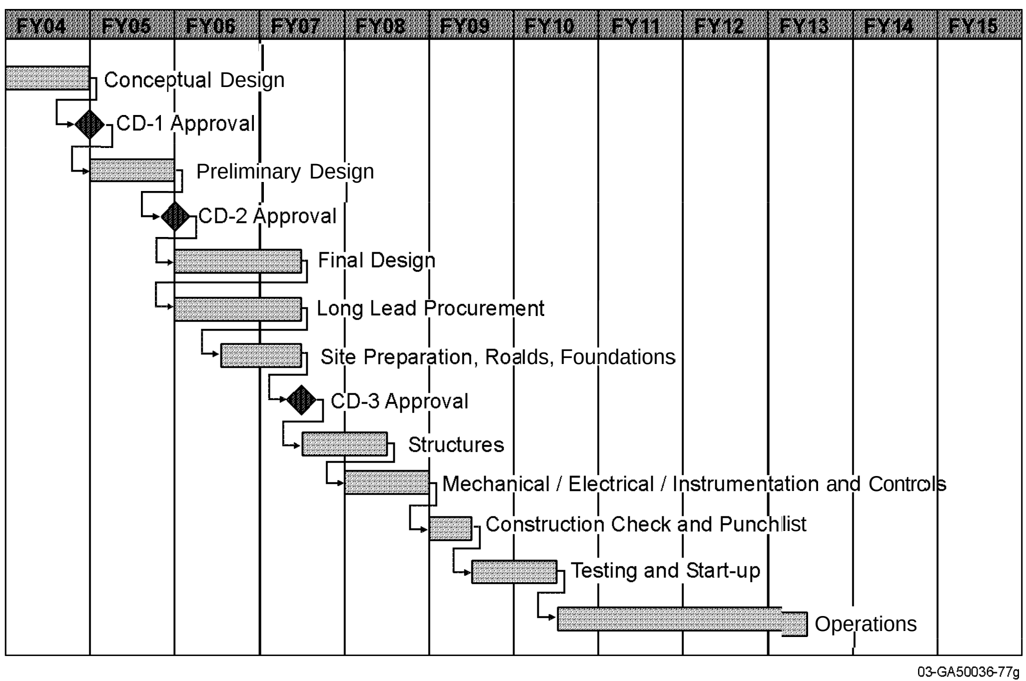

Figure 33. Preliminary schedule of the Pit 9 Remediation Project retrieval activity.

The construction schedule estimates (see Table 9) were based on planning level designs, but they have not been optimized. As the designs develop, constructability reviews will be held to ensure that feasible features to speed construction are incorporated into the design. The completion time to construct the three alternatives is estimated to be within 2 months of each other.

Table 9. Retrieval construction schedule durations.

	Construction Duration (months)	Operations Duration (months)
Alternative 1	35	36
Alternative 2	36	36
Alternative 3	37	36

Construction must be completed in the 3-year period allowed by the *Agreement to Resolve Disputes* (DOE-ID 2002). Construction is anticipated to start before the final design phase is completed, and before the 90% design is submitted to the agencies. Due to the size of the retrieval facilities, construction will be worked in phases. Early site construction includes roads, installation of utilities, sheet piling, and the foundation. This will be followed by the installation of structural, mechanical, and electrical systems.

Retrieval operations for all three alternatives complete within 3 years (see Table 9). The first 6 months are dedicated to overburden removal, the next 18 months to waste retrieval, and the final 12 months to waste return and final disposition.

6. RISK ASSESSMENT

Each alternative was assessed for risks as part of the preconceptual design (see Appendix E). Major risks were first identified by the project team and a risk statement generated. The associated technical and safety risks were then separated from general project risks. The technical and safety risks were assigned a qualitative value for probability of occurrence and consequence of occurrence. The combination of probability and consequence values resulted in a qualitative risk factor. Quantitative values were assigned to the probabilities and consequences in order to evaluate the differences in the initial risk factors for the alternatives. The values for probability and consequence range from 0 to 1. The initial risk factor sum for each alternative comes from multiplying the values for probability and consequence to obtain an initial risk factor value for each risk, and then adding all the initial risk values. The sum of initial risk factors for the alternatives is:

Alternative 1 – 3.20

Alternative 2 – 3.64

Alternative 3 – 3.64

Initial handling strategies were also developed for each risk. The handling strategies mitigate the risk either by lowering or eliminating its probability or decreasing the consequence. The initial risk factors calculated do not include mitigation of the risk by incorporation of the handling strategies in the design; however, the current design concepts include features that mitigate the major safety risks.

The technical and safety risks for each of the retrieval alternatives are summarized in the Risk Analysis Tables in Appendix E. The tables also list possible ways to mitigate these risks. The following list describes the major technical and safety risks associated with the three retrieval alternatives.

1. A significant release of radiological and hazardous material to the environment (possibly reaching a co-located worker and/or member of the public) resulting from a breach in the retrieval confinement caused by a loss of control of the remote-controlled retrieval equipment or an intentional act.

2. Limited facility and/or equipment decontamination, schedule delays, and increased cost resulting from a contamination leak from primary confinement caused by a leak path and loss or reverse of ventilation.

3. Additional cost and schedule delays for investigation, repairs, and restart resulting from damaged equipment and facilities caused by a fire inside the retrieval confinement area.

4. Increases and schedule delays resulting from damaged retrieval equipment caused by a subsidence or operator error.

5. Small cost increases and schedule delays resulting from innoperable retrieval equipment for a short period caused by a subsidence, operator error, or a breakdown.

6. Increased project cost and duration due to agencies requiring the waste under (and around) large objects and highly radioactive waste (remote-handled waste) to be retrieved because it cannot be demonstrated that their risk is acceptable for the protection of human health and the environment.

7. Significantly greater costs, increased storage space requirements, and longer project duration due to agencies requiring materials ≤100 nCi/g TRU to be placed in a RCRA compliant (engineered) landfill.

8. Schedule delays and additional costs due to a release above regulatory limits, Notice of Violations, and fines caused by an inadequate Pit 9 Remediation Project retrieval confinement exhaust treatment of VOCs released by the excavation and retrieval activity.

9. Schedule delays and additional mitigation costs due to encounters with contamination during retrieval activities that the project is not equipped to manage, should the location of Pit 7 be different than indicated in current documentation and retrieval activities.

10. Increased design, material, construction, and final disposition costs, as well as increased duration of construction because the authority having jurisdiction will not waive the noncombustible material requirement and allow the use of a fabric-skinned structure for secondary confinement.

11. Increased construction costs and duration, and DD&D labor costs and duration due to the requirement to divide the retrieval area by firewalls because it is classified as an occupied space and the *International Building Code* (IBC) requirements for maximum area are imposed.

12. Contamination is released to other portions of the retrieval building because the HVAC system causes an over-pressurization of the primary confinement boundary.

13. Schedule delays and increased costs are incurred because information from the GEM project indicates that the containers within Pit 9 are largely intact, necessitating a significantly different retrieval approach.

7. RECOMMENDATIONS

This section provides applicable summary information used in recommending the Front-End Loader–Backhoe Method (Alternative 2) for development in the conceptual design phase of the project.

7.1 Technology Evaluation Summary

Engineers experienced in the technical areas of confinement, excavation, transport, material handling, and contamination control researched, evaluated, and rated waste retrieval equipment, materials, structures, and systems to identify the most applicable technologies for the Pit 9 Remediation Project. This effort is documented in the Engineering Design File (EDF) "Waste Retrieval Process Technology Search for the OU 7-10 Stage III Project" (EDF-4025 2003). (See the accompanying CD for an electronic version of EDF-4025.)

The evaluation of confinement alternatives is documented in Appendix A of the EDF. The alternatives considered vary from large confinement structures to small movable systems. The large fixed confinement structure alternatives received the highest ratings. Movable confinement structures received lower ratings because of the (a) cost and difficulty of each required move, (b) cost and problems involved in cleanup and closure of the excavated area, (c) potential for contamination spread during movement, and (d) difficulty of adequately sealing the primary confinement structure after each move.

The evaluation of alternative primary confinement materials is documented in Appendix B of the EDF. Welded stainless steel and stainless steel received the highest ratings.

The evaluation of alternative excavation and transport equipment is documented in Appendix C of the EDF. Approximately 55 different types of equipment are listed and rated. Support equipment and other specialty features were also evaluated. Comments on the capabilities of each type of equipment are included. Equipment with the highest ratings were selected for further study. A vacuum system is an example of equipment that received a low rating because it had limited capabilities, potential problems with plugging, possible difficulties with hose handling, potential criticality concerns, and required high maintenance.

The evaluation of material handling equipment is documented in Appendix D of the EDF. Ten types of material handling equipment and 13 kinds of material preparation equipment were evaluated and rated. The highest-rated material handling equipment selected for hture study is also compatible with the highest-rated excavation and transport equipment selected.

The evaluation of two contamination control systems are documented in Appendix E of the EDF. They can be summarized as "working clean" and "working soily." Working clean requires minimization of the spread of contamination. Working soily requires remote control systems to perform work and cleanup. The equipment for each type of contamination control is rated; the highest rated ones were selected for further study.

7.1.1 Technology Evaluation and First Down-Select Process

A feasibility study was conducted to evaluate the waste retrieval options identified in "Waste Retrieval Process Technology Search for the OU 7-10 Stage III Project" (EDF-4025 2003), and to down-select a few alternatives for hrther technological evaluation. This effort is documented in *Technology Evaluation of the Retrieval Options for the Pit 9 Remediation Project* (INEEL 2003b). (See the accompanying CD for electronic versions of EDF-4025 and INEEL 2003b.) The down-selection process was achieved through a combination of internal team evaluations and VE sessions involving a larger group from outside the design team.

A structured VE process was followed that used a VE facilitator in accordance with DOE Order 413.3. The first VE session initiated development and evaluation of retrieval system alternatives. Because of the extensive number of possible alternatives remaining after the first VE session, a subteam was used to reduce the system alternatives to 19 for the final VE session.

The final VE session reduced the alternatives to four. Two of the four top-scoring alternatives are similar to Alternative 2 in this report. The other two were similar to Alternatives 1 and 3. Further evaluation and preconceptual design resulted in the three alternatives detailed in Section 2 of this report.

7.1.2 Pit 9 Retrieval Alternative Selection Meeting Record

On June 16, 2003, a group of five "decision makers" for the Pit 9 Remediation Project met to discuss, identify, and weigh decision criteria for Pit 9 retrieval options. On June 17, 2003, a different team was convened to rate the three alternatives discussed in Section 2 against the decision criteria. The record of these meetings, "Pit 9 Remediation Project Retrieval Option Selection Meeting Record," is documented in Appendix F of this report.

During the June 16 meeting, a group of five decision makers selected 20 criterion on which to rate the alternatives. During the June 17 meeting, a different team rated each alternative on a 1 to 7 scale for each of the 20 criterion. They were then to rate the remaining two options relative to that best option. Within each criterion, they were to select the option that best addresses the criterion and rate it a 7. If all the options respond to the criterion equally well (or equally poorly) then all three options were to be rated as a 7. The group was also instructed to "explain" their vote, especially if they rated an option low (1, 2 or 3) for a criterion.

Once all the ratings were completed, the mean rating value for each criterion/option combination was entered into the *Criterium Decision Plus©* software to calculate the final alternative scores. Appendix C of the meeting record (see Appendix F) gives the results of the group ratings. In all rankings, Alternative 2 was the best choice.

7.2 Recommended Alternative

Alternative 2 is the alternative recommended for development in the conceptual design phase of the project. The recommended alternative was selected after considering four key areas; the Pit 9 Remediation Project Retrieval Option Selection Meeting, the project life cycle costs, the estimated schedule, and the risks associated with each alternative.

Based on the distribution of the groups scores discussed in this report, Alternative 2 (Front-End Loader–Backhoe Method) was consistently the best option, and is recommended as the retrieval alternative for conceptual design for the Pit 9 Remediation Project. It received the highest score in the VE session (INEEL 2003b) and the highest ranking in the Pit 9 retrieval alternate selection meeting (see Appendix F). As illustrated in Figure 34, the major difference in scoring was in the area of technical feasibility. The total score represents the normalized scores of each alternative relative to the scores of all three alternatives (normalized score of Alternative 1 equals the raw score of Alternative 1/[the sum of the raw scores of all three alternatives]). The sum of all three alternatives equals 1.00.

Costs were considered in the final recommendation. The estimated TPC and life-cycle costs for each option can be found in Sections 4.1 and 4.2. The estimated TPC of Alternative 2 were approximately $3 million lower than Alternative 3 and $24 million lower than Alternative 1. The life-cycle cost estimate for Alternative 2 was $1 million lower than Alternative 3 and $48 million lower than Alternative 1. Alternative 2 proved to be lower in both the total project and life cycle costs.

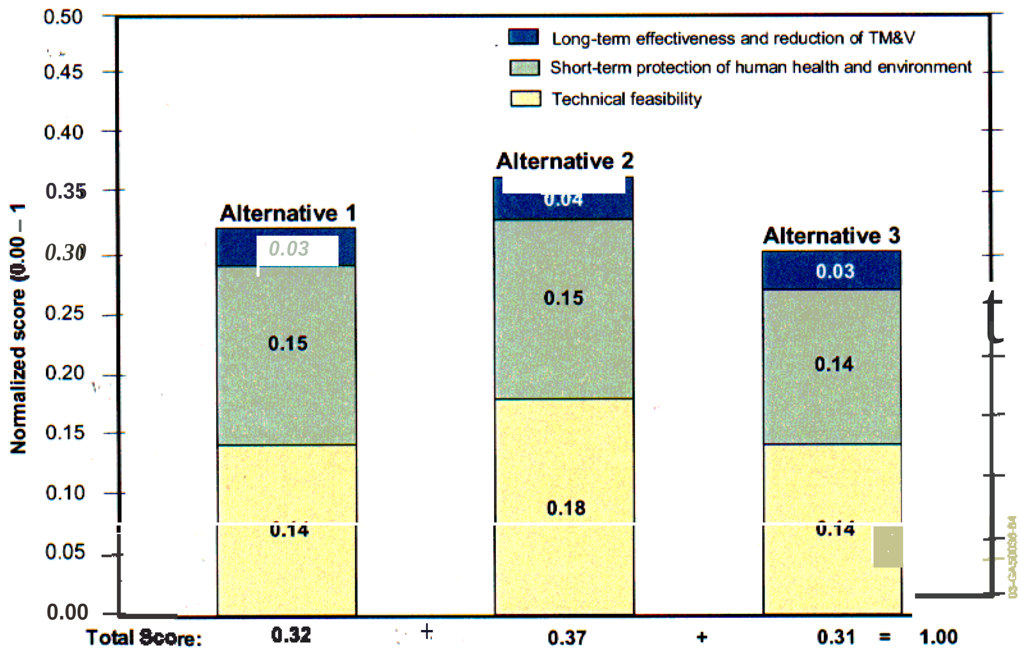

Figure 34. Scoring of retrieval alternatives.

The estimated project schedule was considered in the final recommendation. The schedule variance was minus one month for Alternative 1 and plus one month for Alternative 3, when compared against Alternative 2. The schedule variance comes from the installation issues associated with I&C. It is currently thought that a month variance could be mitigated by correct project controls and is not a factor in the final selection.

A risk assessment was also considered in the final recommendation. Alternative 2 has higher Unmitigated technical and safety risks than Alternative 1 (See Section 6); however, the differences are slight and mitigation of the risks is included in the present design concept. Most of the differences in the preliminary risk assessment between the alternatives were in the area of safety risks that can be mitigated with features in the design. It is therefore, not a large contributing factor in the final selection.

Other noteworthy advantages of Alternative 2 are as follows:

- The confinement structure is 4 ft lower and 40 ft shorter than Alternative 1, and more easily decontaminable

- Transport containers are not required to move waste from the retrieval area
- Larger objects can be removed without breaking them up
- Larger quantities of waste material can be delivered to the characterization location with minimal disturbance than the other alternatives
- Operating time for waste removal is lower than for the other alternatives
- Dust generation and contamination spread occurring from dumping into transport boxes is eliminated
- The mobile equipment used for this alternative can be used for other retrieval projects.

7.3 Other Recommendations

The conceptual design should include a more detailed risk analysis and hrther definition of mitigation strategies.

The future studies listed in Table 10 are recommended in order to mitigate risks, develop better design concepts, and provide information for the final design phases.

Table 10. Recommended future studies.

Subjcct of **Stud!,**	Description
Architectural	Investigate applicable building codes to determine the Occupancy Classification and identify major code requirements defining the design, including life safety, and document all findings in a formal study.
Civil	Perform the analysis and supporting calculations to determine load bearing capacities of soils and soil behavior to support the facility design. Perform surveys and field measurements to determine and verify existing configurations and support for facility design.
Criticality Alarm System	Perform studies to support the design and installation of the criticality alarm system (CAS) and to answer the following questions: • Is a CAS really necessary? • How many detector clusters will be necessary? • Where will the detector clusters need to be located? • Do the CAS units need to be monitored for remote supervision? • Will any CAS supporting structure need to be seismically qualified? • Does the CAS have to operate during commercial power outages? • Can a portable CAS be utilized? • Can the CAS of the GEM project be utilized?
Electrical	Perform a load study of the retrieval equipment and operations for the Pit 9 Remediation Project. Perform calculations in support of electrical power distribution to the Pit 9 site. Develop grounding and lightning protection requirements.

Subjcct of Stud!,	Description
Instrument and Control System	Determine the initial control requirements, types, and number of inputs/outputs, interfaces with operating conditions, and accomplishment of calibration during construction, testing, and operation of the following subsystems: • Monitoring and Control System (M&C) • Radiation and Monitoring System (RMS) • Emissions and Monitoring System (EMS) • Communication/Networking • Closed Circuit Television System (CCTV) Collision Prevention and Remote Control System, Software Management.
Mechanical-HVAC	Perform calculations to establish the heat loss and cooling loads from equipment and activities associated with the primary confinement zones. Develop confinement climate and indoor air quality needs based on requirements of outside airflow rate, recirculation airflow rate, HEPA, dust removal and VOC removal filtration requirements. Determine filtration and scrubber needs based on identified contaminants and associated levels of contamination. Perform calculations to establish the heat loss and cooling loads from equipment, systems, and activities associated with secondary confinement zones. Develop climate requirements for humidity, temperature control, and outside air ventilation for the secondary confinement zones. Determine heat recovery feasibility and any associated cost effectiveness of exhaust air to stack. Evaluate contamination control issues, identify issues and develop procedures for control of infiltration/leakage, etc. Develop over and under pressurization systems for primary and secondary confinement structures, mist elimination system for return air and associated condensate handling issues, and HVAC equipment control schemes for mechanical systems. Determine ducting runs and appropriate methods for installation and decontamination.
Mechanical-Piping	Identify and develop commercially available equipment system needs including sensors and controls, etc. Identify and develop unique systems and components necessary to insure personnel safety and protection of environment through continuous operations. Develop requirements through analysis to ensure that equipment and associated systems function as an integrated system in a remote retrieval environment. Develop recovery plans for identified equipment, Equipment Rescue Plan and Procedures. Perform studies and analysis quantifying risks associated with equipment and systems, including Equipment Maintenance Feasibility Study and Equipment Reliability Risk Analysis. Develop Equipment Operating Procedures including maintenance requirements, [illegible] i control and dec[illegible] methods for equipment.

Subject of Study	Description
Mechanical-Retrieval Process	Determine process flow and rates based on calculations performed to determine: • Excavated material volumes and rates • Returned material volumes and rates • Equipment fueling process • Equipment maintenance process • Required equipment processes for interface between parallel operations (this impacts surge and storage area requirements of the retrieval and treatment facilities) • Process for decontamination of facilities and equipment and identify/validate associated design requirements Processes for the utility, decontamination, and grout modules.
Process Equipment	Perform integration controls study on remote and automated equipment to determine interface and operational methodology between the various process equipment. Perform benchmark studies including: • Sensor Strategy Study – perform alternative studies to optimize selection of sensors, controls, instrumentation and other equipment as determined necessary • Operator Work Station (OWS) Benchmark Study – determine best suited equipment based on methodology to be established during this activity • OWS Interface Study – determine design of layout and components • OWS study – determine optimum design of control platforms • Data Management – determine optimum design for data management station • Camera Study – Define scope, schedule, budgets for visual controls and process integration of a selected system.
Sampling and Analysis	Perform a sampling and analysis study in support of retrieval operations, based on current inventory, address issues associated with Digface sampling and analysis, overburden sampling and analysis, underburden sampling and analysis, captured liquids from decontamination wash bay, and any secondary wastes or residuals resulting from the process systems.
Soil Moisture/Dust Control	The properties of the overburden, interstitial, and underburden soil are important to the retrieval activities, particularly for dust control. The soil properties related to water and application of water need to be better understood and documented. Future studies are needed to obtain soil samples, perform soil testing, and test dust control methods and equipment.
Structural	Perform calculations for the sizing of various system configurations including building foundations, sheet piling, structural framing, and equipment foundations. Evaluate existing structures for structural adequacy for use in support of the proposed facility design. Evaluate technical support relative to natural phenomena applied to structural calculations necessary for mechanical and electrical engineering studies and design.

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